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INTEGRATED CIRCUIT PACKAGE

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Abstract

PURPOSE:To obtain an integrated circuit package not deformed due to a temperature change by bringing the difference of the linear expansion coefficient of a lead frame material and the linear expansion coefficient of a molding resin to 1.4X10<-5> or less.

CONSTITUTION:The difference of the linear expansion coefficient of a lead frame material and the linear expansion coefficient of a molding resin is brought to 1.4X10<-5> or less. It is desirable on manufacture that a lead frame in which a plurality of lead frames 2 at a package unit are shaped is used as a lead frame 1 employed. The lead frame 2 is formed by an IC chip mounting section 2a for fitting an IC chip at a central section and eight lead sections 2b surrounding the mounting section 2a. The lead sections 2b are exposed from a resin surface, a package surface, under the state in which they are sealed subsequently with the molding resin, and employed as terminals. Air gaps 3 take a straight shape, but it is preferable that a lead frame manufactured through etching working is used for increasing adhesive force.

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INTEGRATED CIRCUIT PACKAGE

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Claims

1. An integrated circuit package characterized by the fact that in an integrated circuit package where the lead frame and the IC chip are sealed by a molding resin, after the IC chip is connected to the lead part of the lead frame, such that the entire surface of the lead part is exposed as terminals on the surface of the package, the difference between the linear expansion coefficients of the aforementioned lead frame material and the molding resin is 1.4×10^{-5} or less.

2. The integrated circuit package described in Claim 1 characterized by the fact that the aforementioned lead frame is formed by means of etching.

3. The integrated circuit package described in Claim 1 or 2 characterized by the fact that the surface of the aforementioned lead frame having contact with the resin surface is formed into an embossed pattern.

4. The integrated circuit package described in any of Claims 1-3 characterized by the fact that the lead part exposed at the surface of the aforementioned molding resin is narrower at the edges of the package than in the central part of the package.

Detailed explanation of the invention

Industrial application field

The present invention pertains an integrated circuit package.

Prior art

An integrated circuit package is comprised of an IC chip, lead parts used as external terminals for connecting the terminals of the IC chip to the outside, and a package used as a housing formed by sealing a lead frame, used for mechanically supporting the integrated circuit, and the IC chip with a molding resin.

The integrated circuit package can be classified into the resin type and the ceramic type, each of which has its own advantages and disadvantages. However, the resin type is preferred as far as cost is concerned.

A resin type integrated circuit package is formed by sealing a lead frame and an IC chip with a molding resin, after the IC chip is connected to the lead parts of the lead frame, such that the entire surface of the lead part is exposed as terminals on the surface of the package.

Since this type of integrated circuit package is compact, it enables high density assembly of integrated circuits. Also, it can be manufactured easily at low cost. Consequently, this type of integrated circuit package is used for integrated circuits requiring high assembly density. In particular, it can be used as an integrated circuit package for an IC card.

Problems to be solved by the invention

However, since this type of integrated circuit package has a planar, two-layer structure comprising the metallic lead frame and the molding resin, the package will display bimetallic behavior due to temperature changes. As a result, warping or other deformation can occur to cause malfunctions of the IC chip mounted in the package. The package may even be damaged in some cases. In particular, the aforementioned problem tends to occur in the molding resin

curing step conducted after the IC chip and the leading frame are sealed by the molding resin, leading to a decrease in yield of the package.

Means to solve the problems

The purpose of the present invention is to solve the aforementioned problem.

The present inventor found that if a package is formed by selecting appropriate lead frame material and molding resin to reduce the difference in linear expansion coefficient between the lead frame material and the molding resin used for the integrated circuit package, integrated circuit packages can be manufactured with no deformation caused by temperature changes. The present invention was achieved based on this research.

In other words, the present invention provides an integrated circuit package characterized by the fact that in an integrated circuit package where the lead frame and the IC chip are sealed by a molding resin, after the IC chip is connected to the lead part of the lead frame, such that the entire surface of the lead part is exposed as terminal on the surface of the package, the difference between the linear expansion coefficients of the aforementioned lead frame material and the molding resin is 1.4×10^{-5} or less.

In the following, preferred application examples of the present invention will be explained with reference to figures.

Figure 1 is a planar view of an example of lead frame (1) used for the integrated circuit package of the present invention. Plural package unit (part enclosed by broken line in the figure) lead frames (2) are formed. It is preferred in manufacturing to form multiple package unit lead frames (2) as lead frame (1) used in the present invention. However, if the manufacturing machine cannot handle this, it is also possible to use one package unit lead frames.

Lead frame (2) comprises an IC chip mounting part (2a) having an IC chip set in the central part and 8 lead parts (2b) that surround said mounting part (2a). Lead parts (2b) are exposed at the resin surface, that is, the package surface when the lead frame has later been sealed by the molding resin, to act as terminals. However, the number of lead parts is not fixed at 8. It is also possible for there to be 6 depending on the function of the IC chip used. As shown in the figure, the width L1 of the portion located at the edge of the package is smaller than the width L2 of the portion located toward the center. This makes it possible to prevent the lead parts (2b) acting as the terminals from peeling off in the side surface direction after the package is formed. However, the shape of the lead parts is not limited to that adopted in this application example. The lead part can also be formed with a tapered shape. The lead part can also be formed in a straight shape with a uniform width as long as the adhesion between the molding resin and the lead frame is good.

Given its ability to prevent lead parts (2b) from corroding and its low linear expansion coefficient, it is preferred to use stainless steel as the material of lead frame (1). Examples include JIS SUS 304, SUS430, SUS316, SUS410. It is preferred to use an austenitic stainless steel, such as SUS 304 or SUS 316, which has little magnetism that can cause malfunctions of the IC chip.

42 alloy or other iron-based alloys, or KLF-5, OLIN 194, or other copper-based alloys, which are generally used for lead frames, can also be used taking linear expansion coefficients into consideration. However, it is preferred to plate the terminal surfaces with gold for the reasons described above.

It is preferred for the linear expansion coefficient of the aforementioned lead frame material to be small so that temperature-related changes of the lead frame itself become small. However, taking into consideration the linear expansion coefficient of the molding resin used in the present invention, a lead frame with a linear expansion coefficient in the range of $1x10^{-5}$-1.8 x 10^{-5} in/in/°C should be selected.

Figure 2 shows the cross section along line A-A in Figure 1.

Space (3) between lead parts (2b) and IC chip mounting part (2a) is filled by the resin when the package is sealed with molding resin, and plays an anchoring role whereby the resin and the lead frame are firmly adhered to each other. The shape of the space significantly affects adhesion between the resin and the lead frame. Although not shown in this figure, space (4) (Figure 1) between lead parts (2b), (2b) plays the same role.

The lead frame shown in Figure 2 is manufactured by stamping. Space (3) has a straight shape. In order to increase the adhesive force, it is preferred to use a lead frame manufactured by etching. The space (3) of a lead frame manufactured by two-sided etching, half etching, or another etching process may have various shapes depending on the etching method. Examples include the shape shown in Figure 3 with a large central part and small openings, formed by etching on both sides, and the trapezoidal shape shown in Figure 4 (the small opening is at the resin surface) formed by the one-sided etching method. In either case, since the molding resin filling the space acts as an anchor when the lead frame is sealed by the molding resin, the molding resin as a whole will not come off of the lead frame easily, and the adhesion between the lead frame and the molding resin can be improved. When the bumps and dips (5) shown in Figures 3, 4 are formed in the surfaces of IC chip mounting part (2a) and lead parts (2b), the contact area between molding resin and lead frame is increased, and the bumps and dips act as anchors to further improve the adhesion between the molding resin and the lead frame. In the present invention, it is preferred to change the shape of the bumps and dips according to the molding resin used. These bumps and dips can be omitted, however, if adhesion between the molding resin and the lead frame is particularly good, so that they are not needed.

These bumps and dips can be formed by either a physical method, for example, abrading the lead frame by sand blasting, or by a chemical method such as etching.

A prescribed amount of an adhesive for adhering the IC chip is applied in a prescribed shape to the IC chip mounting part (2a) of said lead frame (2). The IC chip is adhered to mounting part (2a) to form an intermediate assembly before the IC chip is connected to the terminal leads (2b). To adhere said IC chip, the terminal surface of the lead frame is used as the fixing surface, and the lead frame is fixed using the air suction method or a fixture. Since the terminal surface of the lead frame used in the present invention is flat and has no projections for terminals, the lead frame can be fixed easily and reliably on the fixing surface of a processing machine.

The IC chip and lead parts (2b) of said intermediate assembly are then connected to each other by wire bonding. In this case, the terminal surface can also be used as the fixing surface, and the intermediate assembly can be fixed easily and reliably on the fixing surface of the wiring bonding machine in the same way as in the aforementioned adhering operation.

By means of transfer molding, a molding resin is used to perform resin molding in a prescribed shape of this intermediate assembly with the IC chip and lead parts (2b) connected by wire bonding. As a result, the lead frame and the IC chip are sealed to form a package. If the molding resin reaches the terminal surface of lead parts (2b) during the package forming operation, it is necessary to remove the attached molding resin by means of physical grinding or wiping with a solvent.

The ordinarily used molding resins can be used in the present invention. Examples include epoxy resins, silicone resins, epoxy/silicone hybrid resins, etc. It is preferred to use a molding resin with a small linear expansion coefficient because the temperature-related change of the resin itself is small. However, taking into consideration the linear expansion coefficient of the lead frame, it is preferred to use a molding resin with a linear expansion coefficient in the range of $1.5 \times 10^{-5} – 3.5 \times 10^{-5}$ in/in/°C.

When the molding resins and lead frame with the aforementioned linear expansion coefficients are selected, the difference between the linear expansion coefficient of the molding resin and the linear expansion coefficient of the lead frame, which is in the range of $1 \times 10^{-5} – 1.8 \times 10^{-5}$ in/in/°C, can be 1.4×10^{-5} at most, so that the package of the present invention having little deformation caused by temperature changes can be obtained. However, in order to obtain a package with even less deformation caused by temperature changes, the difference is preferred to be 1.0×10^{-5}.

The integrated circuit package of the present invention can be obtained by cutting lead frame (1), having plural packages formed as described above, into the shapes of lead frame (2) of the package unit.

Figure 5 is an oblique view of integrated circuit package (10) of the present invention. Lead parts (2b) acting as terminals are exposed at the surface of molding resin (13) that constitutes the package. As described above, the exposed lead parts (2b) are narrower at the edges of the package than in the central part in order to prevent terminals (2b) from peeling off on the side.

Figure 6 is the cross section along line B-B in Figure 5. IC chip (11) is adhered to the IC chip mounting part (2a) of lead frame (2) via an adhesive. IC chip (11) is connected to lead parts (2b) by gold wires (12). The aforementioned entire body is sealed by molding resin (13). The molding resin (13) filling space (3) acts as an anchor for the purpose of adhesion.

Figure 7 is an oblique view illustrating an IC card having the integrated circuit package (10) of the present invention, formed as described above, assembled in a plastic card. Figure 8 is the cross section along line C-C.

Said integrated circuit package (10) is embedded in a recess formed in a prescribed section of card base material (20), such that the back side of the package is level with the surface of card base material (20). The package is firmly adhered by using adhesive (21).

When this card is inserted into a prescribed card processor, signals can be transmitted between the card processor and the integrated circuit package via terminals (2b) so that information can be processed.

The integrated circuit package of the present invention can also be used for other integrated circuits requiring high assembly density besides cards.

Effect of the invention

The present invention provides a type of integrated circuit package, which is compact, as well as cost effective and enables high assembly density. Since the package is formed by selecting an appropriate lead frame material and molding resin so that the difference in the linear expansion coefficient between lead frame material and molding resin is very small, a highly-reliable integrated circuit package without malfunctions of the IC chip caused by temperature deformation can be obtained, and the yield can be improved when manufacturing the package. The IC card using the integrated circuit package of the present invention is therefore highly reliable because malfunctions will not occur even when the card is used in severe conditions.

In the following, the present invention will be explained in more detail with reference to application examples.

Application Example [1]

Three 0.15 mm OLIN 194 alloy sheets (linear expansion coefficient: 1.63×10^{-5} in/in/°C) were prepared. After the sheet was rinsed and dried according to the conventional method, a photoresist was applied to both sides of the alloy sheet and dried to form a photosensitive film with a prescribed thickness. Then exposure and development, followed by two-sided etching, were performed according to the conventional method to produce a lead frame plate having 5 package unit lead frames sized 20 mm x 20 mm and having 8 lead terminals.

The obtained lead frame was then placed on an air suction table, where the lead frame was fixed firmly with the terminal surface used as the fixing surface. After a die adhesive was used to adhere an IC chip to the IC chip mounting part, the IC chip and the lead parts were connected by means of wire bonding.

The three IC chips were then sealed in the three lead frames by transfer molding using an epoxy resin MH19F-0157 (linear expansion coefficient: 3.2×10^{-5} in/in/°C, product of Toray), an epoxy resin CV 3800 S (linear expansion coefficient: 2.1×10^{-5} in/in/°C, product of Matsushita Electric Works, Ltd.), and an epoxy resin CV 3500 S (linear expansion coefficient: 2.4×10^{-5} in/in/°C, product of Matsushita Electric Works, Ltd.), respectively. The lead frames were then cut at the prescribed positions of the package units to obtain 3 types of integrated circuit packages of the present invention.

The integrated circuit packages obtained were embedded in plastic cards such that the terminal surface of the package was level with the card base material to form an IC card. An epoxy adhesive was used for adhesion to the package card base material.

When the IC card formed was inserted into a prescribed card processor, signals were transmitted between the card processor and the integrated circuit through the terminals to process information in a desired manner.

Application Example 2

Three 0.15 mm-thick SUS 304 sheets (linear expansion coefficient: 1.73×10^{-5} in/in/°C, product of Dainippon Printing Co., Ltd.) were prepared and processed in the same way as described in Application Example 1 to obtain 3 types of integrated circuit packages of the present invention.

Application Example 3

Three 0.15 mm-thick 42 ALLOY sheets (linear expansion coefficient: 0.43×10^{-5} in/in/°C, product of Dainippon Printing Co., Ltd.) were prepared and processed in the same way as described in Application Example 1 to obtain 3 types of integrated circuit packages of the present invention.

Comparative example

A temperature cycling test was conducted (conditions: a cycle from a low temperature of -55°C to a high temperature of 150°C was repeated 100 times) for the 9 different integrated circuit packages obtained in Application Examples 1, 2, 3 described above. As can be seen from the test results listed below, good results were obtained for packages with a linear expansion coefficient difference smaller than 1.2 x 10^{-5} in/in/°C.

Results of temperature cycling test

	Application Example 1 OLIN 194	Application Example 2 SUS 304	Application Example3 42 ALLOY
MH19F-0157	Good (0.47)	Good (0.37)	Large deformation (1.67)
CV 3300 S	Good (0.77)	Good (0.67)	Damaged (1.97)
CV 3500 S	Large deformation (1.57)	Good (1.47)	Damaged (2.77)

Note: The value in ( ) in the table is (linear expansion coefficient of the resin) – (linear expansion coefficient of the [lead] frame material) x 10^{-5}.

Brief description of the figures

Figure 1 is a plan view illustrating the lead frame used in the present invention. Figure 2 is a cross section along line A-A shown in Figure 1. Figures 3 and 4 are the cross sections at same position as that in Figure 2 for lead frames of other forms. Figure 5 is an oblique view of the integrated circuit package of the present invention. Figure 6 is a cross section along line B-B in Figure 5. Figure 7 is an oblique view of an IC card formed by using the integrated circuit package of the present invention. Figure 8 is a cross section along line C-C in Figure 7.

1 Lead frame
2 Lead frame of package unit
2a IC chip mounting part
2b Lead part
3 Space between the IC chip mounting part and the lead parts
4 Space between lead parts (2b)
5 Bumps and dips on the surface of the lead frame
10 Integrated circuit package
11 IC chip
12 Gold wire for making connections
13 Molding resin
14 Adhesive for adhering IC chip

20 Card substrate

21 Adhesive

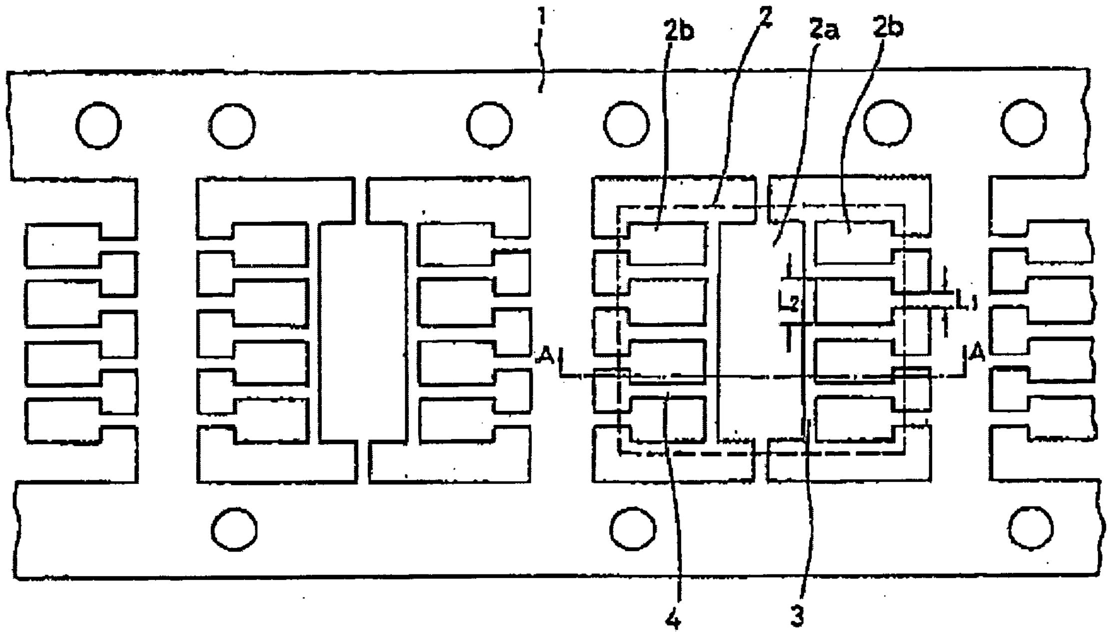

Figure 1

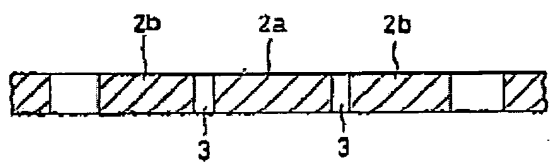

Figure 2

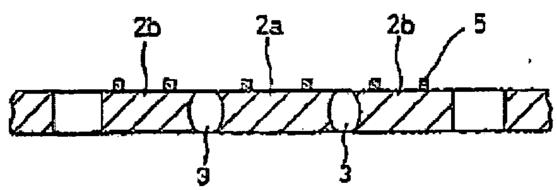

Figure 3

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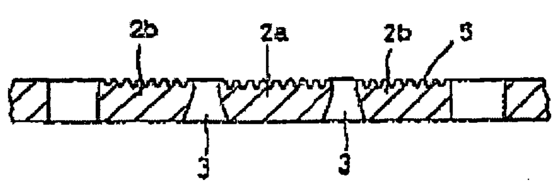

Figure 4

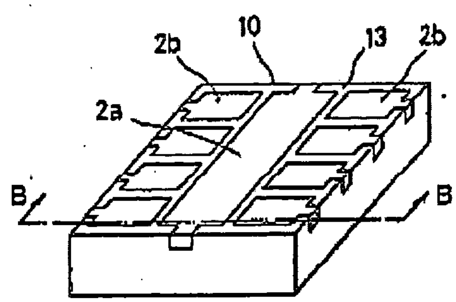

Figure 5

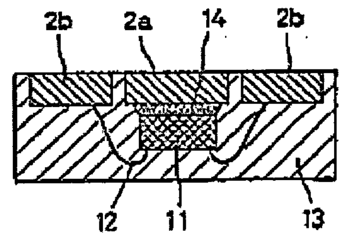

Figure 6

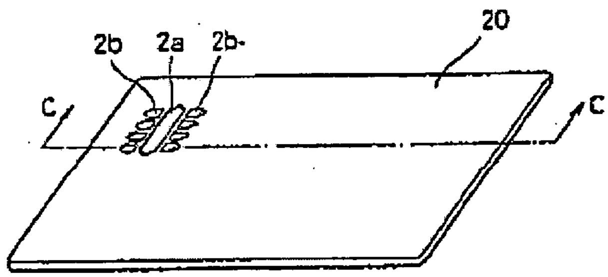

Figure 7

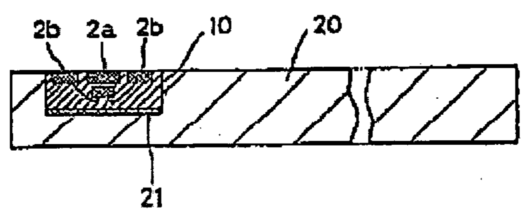

Figure 8